

IN THE SPECIFICATION:

On page 14, please amend the following paragraph as follows:

“For example, in a preferred embodiment, we select a reference wavelength $\lambda_0 = 248,327.1$ pm (corresponding to an absorption line of an iron hollow cathode lamp). At this wavelength, the fringe diameter D_0 might be found to be 300 pixels. C_d is a constant which can either be directly measured or calculated from the optical design. In our preferred embodiment, $C_d = -9.25 \times 10^{-5}$ pm/pixel². Thus, for example, with the laser operating at a different wavelength, the fringe diameter may be measured to be 405 pixels. The possible wavelengths computed by equation (1) are:

$$\begin{aligned}\lambda &= 248,327.1 \text{ pm} - 9.25 \times 10^{-5} \text{ pm/pixel}^2 [(405)^2 - (300)^2] + N \cdot \text{FSR} \\ &= 248,333.95 + N \cdot \text{FSR}\end{aligned}$$

On page 15 please amend the following paragraph as follows:

“The inner and outer fringe diameters D_1 and D_2 as shown in FIG. 16B are each converted into wavelengths λ_1 and λ_2 , respectively. The final value which is reported for the laser wavelength is the average of these two calculations:”

$$\lambda = \left(\frac{\lambda_1 + \lambda_2}{2} \right)$$

On page 16 please amend the following paragraph as follows:

“Wavelength Calibration

About 10% of that portion of the beam that passes through mirror 182 are reflected from mirror 186 into fiber optic input 188 and the light travels through an optical fiber to atomic wavelength reference 190. The optical fiber connects to atomic reference unit 190 at opening 191, and the light from the optical fiber reflects off mirror 69 192 and is focused by lens 193 to a focal point in the center of neon iron vapor cell 194, and is focused again by lens 195 onto photodiode 196. Atomic wavelength reference unit 190 is used to calibrate wavemeter 120. This is done by adjusting the wavelength of the laser while keeping the output energy constant as shown by detector 69 while monitoring the output of photodiode 196. When

photodiode 196 shows a substantial reduction in output while photodiode 69 shows nominal output, the wavelength of the output must correspond to the iron vapor absorption line of 248.3271 nm. The position data corresponding to the etalon fringes and the position data corresponding to the image produced by grating 176 on linear photodiode 180 when the output of photodiode 196 is lowest is detected and recorded by wavemeter controller 197 and this data are used by wavemeter controller 197 to calibrate wavemeter 120.”

On page 17 please amend the following paragraph as follows:

“Correction of Bandwidth

The bandwidth measurements made by the spectrometer equipment shown in FIG. 6 provides bandwidth values that are ~~larger~~ different than the true ~~wavelength bandwidth~~ values because like all spectrometers has its own spectrum called a “slit function” which is the spectrum which it would display when monitoring a monochromatic beam.”

On page 17 please amend the following paragraph as follows:

“FIG. 15A shows qualitatively a typical spectrometer slit function and a hypothetical true spectrum. The measured spectrum would be a convolution of the slit function and the true spectrum of the laser beam. Thus, to determine the true spectrum from raw spectral data from a gas discharge laser, the slit function must be removed. This turns out mathematically to be very difficult to do.”

On page 18 please amend the following paragraph as follows:

“The stack 80 responds to a control signal within less than 1 microsecond and the system can easily respond to updated signals at a frequency of 2000 Hz. In a preferred embodiment the control for each pulse at 2000 Hz pulse rate is based not on the previous pulse but the pulse prior to the previous pulse to allow plenty of time for the wavelength calculation. However, this embodiment provides a factor of 7 improvement over the prior art design with a 7 millisecond latency. Therefore, much faster feedback control can be provided. One preferred feedback control algorithm is described in FIG. 12C. In this algorithm the wavelength is measured for each pulse and an average wavelength for the last four and last two pulses is calculated. If either of the average deviate from the target wavelength by less than 0.02 pm, no adjustment is made. If both deviate more than 0.02 pm from the target, an adjustment is made to the mirror assembly by piezoelectric stack 80 to provide a wavelength correction.

Which of the two averages is used is determined by how much time had elapsed since the last adjustment. The piezoelectric stack is maintained within its control range by stepping the stepper motor as the stack approaches 30 and 70 percent of its range (or to provide more available range, 45 and 55 percent could be used instead of the 30 and 70 percent range values). Since the stepper motor requires about 7 ms to complete a step, the algorithm may make several piezo adjustments during a stepper motor step.”

On page 19 please amend the following paragraph as follows:

“In this embodiment these piezoelectric stacks 88A, 88B, and 88C provide very fine adjustment of the position of mirror 14A relative to mirror mount 86A. As in the above example, the total adjustment range of the piezoelectric elements 88A, 88B and 88C can be very small such as about 1.5 micron since large adjustments are provided by the stepper motor. Adjustment of this lightweight mirror with the three piezo elements over very small distances such as about 0.1 microns can be extremely fast in the range of about 10 microseconds. The mirror position can be adjusted by moving drive 88A in one direction and drives 88B and 88C in the opposite direction or by moving drive 88A only. As in the prior example, preferred control algorithms outlined in FIG. 12D calls for a stepper motor step if the piezo position reaches as low as about 30 or as high as 70 percent of the control range. This provides a control range without stepper motor movement of 160 nm which is equivalent to about 0.8 pm to about 1.6 pm (depending on whether one or three piezo drivers are used). Therefore, the very fast piezo controls have a range sufficient to control substantially all chirp variations which, as indicated in FIGS. 15A, are typically within the range of ∇ 0.10 pm. Larger wavelength changes are provided by the stepper motor.”

On page 20 please amend the following paragraph as follows:

“The algorithm outlined in FIG. 12D provides pulse-to-pulse control of the laser wavelength permitting next pulse correction using the very fast mirror design shown in FIGS. 13A, 13B and 13C. The algorithm as described in FIG. 12D awaits completion of a pulse N which it redefines as pulse N-1. It measures the wavelength of the pulse, compares it with a target pulse and moves stacks 88A, 88B and 88C ~~together~~ or stack 88A ~~alone~~ to provide the desired wavelength correction. All of this is done prior to pulse N so that the mirror is moved and is stationary at the time of pulse N. If any of the stacks are outside of its 30% to 70% range, the

stepper motor makes a step. The algorithm will then cause the out of range stack to move back within the 30% to 70% range. The position of the stacks are based on their control voltage. The algorithm could be modified so that no piezoelectric adjustment is made if the absolute value of δ is less than a specified small value such as 0.01 pm which is 20% of one specification value for wavelength variation.”

On page 21 please amend the following paragraph as follows:

“Mirror Position Determination

In some cases it may be desirable to control the wavelength by specifying particular mirror positions. This can be done with the embodiments shown in FIGS. 14 and 14A. In this embodiment a diode laser 86 provides as shown in FIG. 14B, a beam which is reflected off mirror 14C and the reflected beam is focused on a photodiode array 90 to determine the pivot position of mirror 14C. This arrangement permits precise positioning of the mirror without having to operate the laser for an actual wavelength measurement. This could be important when accurate prepositioning of the mirror is desired. FIG. 14A B illustrates a technique of increasing the optical distance between mirror 14C and the PDA array to improve precision of the pivot measurement.”